Expansion Joint Design
Ancillaries Design - Design Software User Manual
RecBel

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Introduction

This User Manual is for the RecBel program and how to use it to design rectangular bellows.

This manual gives a good overview of the program but also smaller details, tips and warnings.

Additional resources

There are additional documents to read:
- Program help file. Press F1 key to activate it. Help file is contact sensitive so where the cursor is the help file opens for that entry or result. All images and formula have hot spots. Click any parameter in a formula and additional details are available
- Installation of Bellows Software.pdf
- How to use Software.pdf
- NewComputer
- Registration.pdf
- How to enter new material at http://www.jat.co.za/bmsupport.html
- Contact developers

Installation and Uninstallation

RecBel has a standard Windows installation file. After downloading the installation file into a temporary folder simply double click the installation file in Windows Explorer. It is also known as File Explorer and My Computer. In Windows 10 it is known as File Explorer.

Installation programs install the program files into a folder (WIN 10):

C:\Program Files (x86)\J Tolonen Services cc\Bellows\Design2

Installation includes a limited material database. The user can update or enlarge the database using MatTool II program. Easier and more economical way is to purchase an additional material database from the developers. This database is common for all programs excluding those based on EN standards.

All of the programs are "low volume" and this is causing problems with some virus protection programs. Developers are signing the installations using agreed system by the virus protection program developers. Not all of the developers use the system and even those who work with the system have false reporting from time to time. Unfortunately even this system has been discontinued. There has never been any confirmed report or detection that bellows design software has virus or other unwanted code. Many developers have similar problems with "low volume" software or software updated regularly. Sometimes programs have been in use for more than 20 years without any issues and suddenly they are removed as "dangerous". The best solution is to ask your virus protection supplier to double check. They will add the software to be accepted and on a safe product list.

Warning: Windows Vista and later versions have increased security. You need to have administrator rights to do the installations. Sometimes even this is not sufficient depending on your company's IT policies. The first trick is to try to run the installation program by right clicking on the installation file and selecting "Run As Administrator".

The program uninstallation is done via the program uninstallation option in Control Panel.

Program registration

RecBel requires registration before it can be used. Licenses are a computer and partly a user specific. Each computer requires own dedicated license per program. License is locked to the computer identification collected during the licensing procedure, see below. Because the licensing information is saved into the Registry under Current User key, the license has to be entered for every user where the computer is used by multiple users having different user names.

Registration is two step process. The first step is to request a license. The second step is to enter it after the license is received.

Terms License, Key and Certificate mean the same thing.

License Request

Steps to follow to request the license:

1. Install the program on the computer you are going to use for testing or for permanent installation. We recommend you use the standard installation and default file locations.

2. Start the program.

3. New form opens. This is for registration.

4. Click the last button with a hint "Request for license"

5. New form opens

6. Enter requested information

7. Click the second button "Collect information"

8. Click the last button "Copy to clipboard"

9. Open your e mail program and start a message to us

10. Paste the clipboard content into the e mail. The result looks something like the following:
-----------Do not change the following-------
Jouko Tolonen jouko@jatsa.biz

PinMaster 1.0.0.0
41940
1057-4E4B-5E3C-9DA0-7F93-C26B-D383-30F8
-----------End of request------- Comments to developers:

12. Send the e mail to developers

If the computer you are using has no E mail possibility then you can use a notepad program to transfer the license request to another computer. The notepad is part of each Windows operating system and makes simple text files *.txt. Save the file onto a disk for the transfer.

If you are installing multiple programs on the same computer, you do not need to issue the request for all of them. Simply create one request and in the e mail list the programs for which you require the license.

RecBel is sold per license. License issued for one computer will not work on another. License can be transferred on request to a new computer or to another user.

Entering the License

After receiving the license, which is sent via e mail in *.txt file format it has to be entered to the program the license is for. A license file name identifies for which program the license is for. License file for PinMaster is named PinMaster_License.txt. Depending on the Windows settings you may not see the file name part ".txt". As a default it is hidden by the operating system. This is a serious security issue and you should always change the setting to prevent unintended installation of dangerous viruses and mal ware.

To enter the license start the program. If the licensing form doesn't open automatically simply click the button or menu item to open the entry form. After the license entry form is open follow the steps:

1. Copy the license from the first to the last character as describe below using copy command or key combination CTRL plus key C. Typical license file looks like:

Old Type:

Key:
3BT74OHO-QOOQEK6C-E36GIOOE-K2NJB527-MVVZ7WNO-TUFABXYV-7XRFB ARQ-CPQR6EYA-2UUOOCQ2-73RAEAKQ-RATRZ3SZ-TMBRHLIA-ABSMWQPG-G AWAEFAN-UEJ6HA4M-VPINDA7A-P4YEKZXJ-BLISLSYC-CRCEOT2U-OZLVQQQ M-6YMIZOM3-DW6CSKH2-KMERQBPT

If you receive the old type, you need to be careful when copying the license. The cursor has to be just after the last character and not on the next line. Allowing the cursor to be on the next line you may copy invisible character and the license entry fails.

New Type:

Key:
*begin_data*FT45RY6J-ZOWLYTDF-GDM4Q6CP-4K72QIYS-IMG6ITUX-VLAIBDJ 3-CAAON7P2-4ICE72WH-AMO6CFPL-KCJWABQA-7H4PPOYF-NAHQB44H-BR4P BAID-AQEGFEYG-B5DJWQOH-NAGTALIC-CR5AC7H3-36G6QH7X-AQG2J35U-N

BI3C3J5-54BBKAEY-G4VAMRJW-XHP3D2EW-PXNWIJAB-AHBXMHIP*end_data*

New key type is implemented fully as the programs are updated. Initially the user is required to copy the licence between special markers *begin_data* and *end_data* without including any part of the markers. Later when the programs are updated all characters can be copied and licencing system excludes automatically characters that are not part of the licence.

2. Click second button from left on the registration form. This has a hint "Load license from clipboard"

3. Click button Activate Program

4. Read all messages. You should get information that the program is registered. If you receive an error message write it down (each error) or preferably take an image and send them to us.

If the license entry fails please consider first the Old and New type license issues. After that close the program and try again. If it fails the second it time contact the supplier via e mail and send images of all error messages you get. Entry may fail due to misunderstanding, company security policies or by some other reason. All cases have been solved.

Program Settings

RecBel has number of initial settings. This Chapter describes the minimum steps you are required to do.
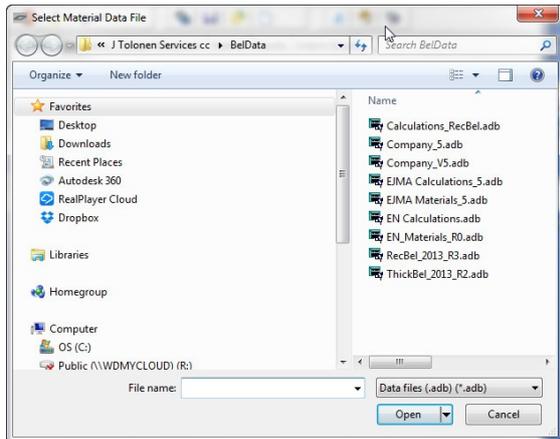
Material Database

RecBel requires material data for the calculations. After an installation and registration program doesn't know which material database to use or where it is located. The user has to set this up.

When the program restarts after the registration and gives a warning that the material database is not set you will not be able to use the program before this setting is done. To do the setting you use RecBel Menu: Setup - Set Material Database, see the images how to do this:
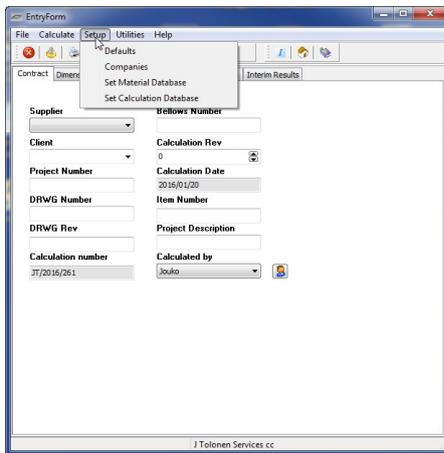
Figure 2 Click Help button for additional details

RecBel installation includes a limited material database which is named like RecBel_2013_R5.adb. Your operating system may hide the part ".adb". R5 may change. It shows the revision of the database. 2013 shows on which edition of ASME II D the material values are based.

Additional material databases are named slightly differently. For instance database file name: EJMA_2019_Mat_R10_5.adb is based on 2019 edition ASME II D, it is Revision 10 and number 5 identifies the database engine version used.

Tip: If you purchased the additional material database the easiest way to save it to the default location is to copy and drop it into the window listing the databases.

Click the database you wish to use and click Open button. Selection of the database is only activated after restarting the program.

Depending which programs, your company has purchased you may find different database names. Some of those are for calculations or material values for different design codes. In addition your company may have modified or created own databases with different naming convention.

Database locations are saved into the registry. If the registry would get corrupted or you have reinstalled Windows you need to reset the file locations.

RecBel has very minimal checking that you have actually selected the correct database. After setting the database if you get strange errors, you do not see expected results or materials you may have totally wrong or outdated file in use. If you keep changing the database establish some form of revision control so that you know what is the file you should use.

If you purchased an additional database, you can either save it to the same location as the one supplied with the program or any other location you wish to use. You just need to point the program to the correct file. Which material database is used can be changed at any given time but it requires restarting the program.

Default material database locations are:
NT/2000/XP: C:\Documents and Settings\User\Application Data\J Tolonen Services cc\BelData
Vista/7/8/10:   C:\Users\User\AppData\Roaming\J Tolonen Services cc\BelData.

"User" is replaced by the current user's name.

You can have the databases in any other location. If they are on the server then the path to the server folder has to be permanently captured.

Calculation Database

Steps to set up the calculation database are the same as the material database. Default name for the database is Calculations_RecBel.adb.

This database is the one you have to back up. If you lose it, you lose all of your saved calculations. The database can be located on the company server or any other location.

Company Logo

RecBel uses the same Company file as BellowsMaster II and BellowsMaster II EN and some other programs from the developers so if you have any one of them the setting needs to be done only one time by any one of the programs.

The program can have unlimited number of company logos. Most need only one but consulting company may have very many. Set up is via program Menu Setup - Companies. When the entry form opens click key F1. In the help file there is an image. Click each entry field (white areas) and read the details.

Recommended logo size is given in the help file. The program is designed for a rectangular logo. If your logo is different shape use some image program and allow white space where required to get rectangular shape. A logo file must be in BMP format.

Unfortunately Paintbrush, which is part of Windows doesn't work here. There can be other programs with the similar problem. If the logo vanishes when you click "Post" (Save) button the image program is not suitable. BM II installation includes Frequently Asked Questions (FAQ) document. Solution to this issue is described there and the same details are given here:

There is a known issue concerning the creation of company logos for printing purposes. Logo files saved using some versions of Windows Paint programs are not compatible with the graphical module used in Bellows Master II and other programs using Company.adb. If you experience a problem that after entering your logo file into Bellows Master II it vanishes, e.g. will not print or show your logo file is in wrong format. The solution is to open the logo file (*.bmp) in and other program and use "SaveAs" command. One program tested to give the correct result (File format) is freely available IrfanView (http://www.irfanview.com/).

The easiest way is to open the BMP logo file in IrfanView and then use menu Edit - Copy. When this is done and you have the company logo entry form open simply do the following steps:
- Click a small button with + sign
- Enter short company code
- Enter a company name
- Click 2nd button on top to paste the logo
- Click the Post button with a Tick image

Done

Entry form is for a database. Database programs work differently to programs like Excel and MS Word. One big problem is the use of many buttons in the bottom. Saving is called Posting etc. Each button is described in the help file. Just click each button in the help file image and there is description.

Program Defaults

Using the program is much easier if the program settings are done. The program defaults are in Menu Setup - Defaults.

Defaults form has two Tabs "Entries" and "Other". Go into any of the entry fields and press key F1. Images open and by further click on the image explanation is given. Please read additional details on each entry from the help file.

Note that the "Calculated By" drop down list is empty until you have entered name or names on the main program.

Couple recommendations:
- Consider entering calculation prefix. In the long run it is handy
- Consider selecting "Show working spring rates". This is not in EJMA for the rectangular bellows. For round bellows the factor is 0.67 when the movement is large enough.
- Note "Clear display on new calc"

All of the settings can be changed at any time - even in the middle of a calculation.

When completed click OK button and all entries are written into the registry. Clicking Cancel doesn't change entry entries in the Registry.

To get additional details click any of the default entries and then press key F1. Help file opens showing two images. Using mouse click fields in the images and most of them have detailed information what they are for.

The First Design

Programs have many Tabs. Entries can be done in any sequence but recommended is the listed Tab sequence and entering from left top corner down and next column from top.

- Contract
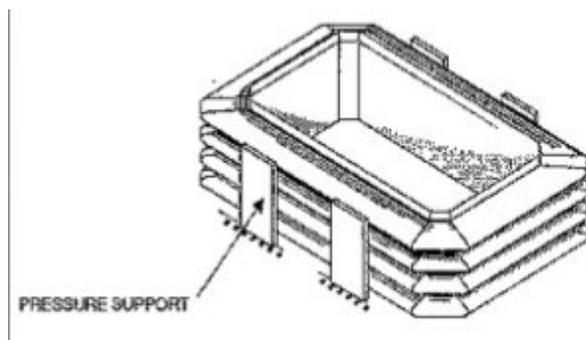- Dimensions
- Design Parameters
- Material

Calculate

Contract Tab

On the Contract Tab you have several entries. You do not need to enter any one of them but it is highly recommended to use them. Entries are used on the reports. The program has revision control. You can save unlimited number of calculations. Only the entries are saved and no calculation results.

Revision control is handy. You use it as you would use drawing revisions. It is recommended that you do not use the revision control of the design case calculation for pressure test calculation. Rather, use separate calculation number. After you are happy with the design condition calculation make sure that the tick mark is not on in the program defaults on "Clear display on new calc". Then make sure your calculation is open and click "New calculation" button. Change the calculation to Pressure test calculation and then change the temperature, pressure and movement entries. Save and calculate.

Dimensions Tab

Most of the entries are clear. Using key F1 you do get detailed information. If your defaults were set, you have pre-filled entries. You can change any of the entries as required.

Figure 4 Pressure stops

A nipple is the duct/pipe section between two elements. Number of convolutions is

always per element.

What is the convolution height is shown in the help file. It is not the dimension from inside to the top of the convolution!

Pressure stops are not in EJMA. This is one of the additional features in the program. Help file has additional details including limitations.

Where there is internal pressure and the element is welded inside the duct then the ends are supported.

Design Parameters

Entries on this tab are critical and require some additional explanations.

Externally pressurized

If the inside pressure is higher than the outside then select No. This is the normal case. In some cases you have lower internal pressure that the pressure outside. Sometimes this case is called "vacuum". RecBel entries do not work on negative pressures on the externally pressurized case. The program uses absolute pressure values.

Designers tend to get confused with absolute, gauge and negative pressures:
- Absolute standard pressure on sea level is 101.325 kPa
- Standard gauge pressure on sea level is 0 MPa and also 0 kPa
- Where vacuum pressure is given as a negative value like -20 kPa then the absolute value to use ON SEA LEVEL is (101.325-20)kPa = 81.325 kPa or 81 kPa

Atmospheric pressure depends on the elevation. In some cases you can use the standard pressure at the plant location. Only thing that changes is the value of 101.325 kPa.

When using the external pressure option note the units used. Assuming the customer has asked a full vacuum and the duct is on free air then the inside pressure entry is zero and the design pressure 0.101 MPa (a) for the sea level.

Fatigue Design

Fatigue design on rectangular bellows is problematic. EJMA has the formula to calculate the number of cycles but no values for factors a, b and c. "Fatigue data must be furnished by individual manufacturers." This is expensive and time consuming as there are many parameters that can have an influence.

RecBel developers have done literature research and added features to the program which can be used.

The real "deal" would be to do the fatigue tests and establish the factors a, b and c. These can be entered into the material database for each of the materials, e.g. factors are material specific.

EJMA has two other factors for the calculation of the stress value to be used in the fatigue life formula 5-35. These factors are C_{sp} and C_{sf}. The program has default values 0.7 and one, which are those used for the round bellows. Each manufacturer is responsible for establishing these.

To cater for different corner configurations, V or U element shape and for any other reason the designer needs to adjust the cycle calculation RecBel has Fatigue Safety Factor.

Fatigue Safety Factor

From the help file:

A fatigue safety factor is an additional factor you can use to change the design evaluation. Normally you enter one. Value below one means that your design is less stringent than standard calculation. Value above one gives you additional safety against fatigue. This factor is not considered if calculated allowed cycles are above the maximum cycle limit set for the material. By double clicking the field default value is automatically entered.

Note: EJMA 10 introduced a factor fc for the round bellows. This has not been incorporated into this program. The factor is included for round bellows only and the Fatigue Safety Factor as described here is more suitable for rectangular bellows.

Typical uses could be:

You have estimated or tested that rectangular bellows with rounded corners has half the life expectancy of a round bellows by using EJMA fatigue calculation and round bellows fatigue factors you could enter two as fatigue safety factor and your calculation would be safe.

You have estimated or tested that the fatigue life of a rectangular bellows with a single miter corner is one tenth of the rounded corner version by entering 2 x 10 = 20 as the safety factor your calculation would be safe

Above are just samples. Developers of the program have done no tests and therefore do not know if above used two and 10 are even near by the correct values.

Developers have done substantial literature research. The following statements have been found:

- Rounded corner design fatigue factors can be considered to be similar to EJMA round bellows factors
- A rounded corner has about six times the fatigue life of camera or mitered corner
- A rounded corner has about ten times the fatigue life of camera or mitered corner
- A rounded corner has more than 70 times the fatigue life of camera or mitered corner. This statement is for very short radius round corner design.

Mitered corners are assumed to be those with one weld only. A mitered corner with

two welds can be assumed to be better than those with one weld only.

Fatigue Type

RecBel has two options: EJMA and Ferritic. When you select EJMA fatigue factors a, b abd c are taken from the material database. In all databases supplied by the developers those values are factors given in EJMA for the round bellows and selected material type.

Ferritic calculation doesn't use any factors. Calculation method is based on literature and is valid for ferritic materials like mild steel.

Stresses on pressure test case are evaluated against 90% of the yield. Recommended maximum deflection limit is not adjusted for the pressure test.

Spring rate for rotation movement is most probably double that it should be. EJMA has a conflict since EJMA 8 in formula. This is reported but not fixed. RecBel is conservative and is using the formula giving higher spring rate. In case there is a design problem as a result please contact the developers. As at June 2021 EJMA has no scheduled Errata, Addenda or Edition.

Material Tab

On the material tab you select the bellows element, nipple and pipe end materials as required. The fastest way to find the correct material is to use the search button. Search string is case sensitive and is searching the full material descriptions.

Result Tab

Result Tab shows the calculated results. There are seven different fields for the stresses. Pressing key F1 will show the formula used. In the formula you can click any of the parameters to drill down what is behind that specific parameter.

It is important to note that depending on the design some stresses are set to zero. Exact rules are given in EJMA standard. Help file gives short comment like for S_{7s} "If there is only one convolution the stress is set to be zero."

All designs are evaluated and any warning or failure is shown in the Error Messages.

Design Warning

EJMA design is based on beam theory. Explanations and guidance are limited. Considering EJMA and ASME paper PVP2007-26010 it is clear that the pipe ends and center pipe (nipple) have to be sufficiently rigid that they do not deform in a meaningful manner. This is demonstrated by the fact that stresses and deflections are set to zero where there is only one convolution.

Designer is required to calculate the ends and center pipe separately. Rectangular tank design rules or similar could be used for this purpose. Possible methods to use:

- ASME VIII Div 1 Appendix 13

- British Engine Technical Report 1981 Volume XIV "Non-Circular Pressure Vessels - Some guidance notes for designers"

- Thesis: Tharani Thange, "Design method for large Rectangular Industrial Ducts", 2012, McMaster University - Ontario, 341 pages.

Experience has shown that the center pipe length only is insufficient then calculating the force effecting on the center pipe walls. As a minimum half width of the elements have to be also considered.

You may need to know the Moment of Inertia of the bellows element. This is given in the full list of the parameters available from program menu Utilities - Show Variables.

RecBel is not evaluating the pipe ends or the nipple. Rectangular shape likes to be round under pressure. It is critical that the designer verifies the these two parts. In many cases the nipple has to be reinforced by really heavy H beam or something similar.

Interim Results Tab

This tab gives additional details you may need.

Printing

Program has printed reports. To print them there is a button with a printer icon.

There is a possibility to make PDF out of the print report directly from the program. When the preview of the print report is shown there is a typical Save button. Click that and new form opens. First change "Save as type:" in the bottom to PDF. Enter name into "File name:" and then navigate to folder (directory) where you wish to save the report and click button "Save".

In addition to the formal report there is a possibility to print full listing of parameters used by the program. You get this from Menu Utilities - Show Variables. Original purpose of this listing was to be able to verify the correctness of the calculations. This print can be confusing and normally should not be given to a customer.